Row	B	C	D	Description
50				
51		total links	=SUMPRODUCT('wire center investment'!F2:F2200,'wire center investment'!Z2:Z2200)	
52		total link investment	=SUMPRODUCT('wire center investment'!F2:F2200,'wire center investment'!AA2:AA2200)	
53		average link inv	=IF(D51=0,0,D52/D51)	
54		total tandem A links	=2*(D4+H7)	
55		total C links	=4*(D18)*inputs!C101	
56		equiv tdm A links/C links/line	=(D54+D55)/(D5+D6+D7)	
57				
58				
59	Total SCP investment per line		=inputs!F61	
60	Total SCP wire center investment per line		=(inputs!$E$139*inputs!$D$139+inputs!$C$139)/(D5+D6+D7)	
61				
62	Average ring distance per node, mi		=IF(COUNT('ring io'!AN:AN)=0,0,SUM('ring io'!AN:AN)/COUNT('ring io'!AN:AN))	
63	Average tandem distance, mi		=SUM('distance inputs'!C:C)/COUNT('distance inputs'!C:C)	
64	Ring + interconnector distance adjustment factor		=IF(SUM('ring io'!AN:AN)-'distance inputs'!AC2=0,0,(SUM('ring io'!AN:AN)+'distance inputs'!$X$2+'distance inputs'!$Z$2)/(SUM('ring io'!AN:AN)-'distance inputs'!AC2))	This calculation produces an adjustment factor applied to ring distances to accommodate the additional distance covered by inter-ring connections; it is applied to the ring distance calculation in the wire center investment sheet

Row	F	G	H	Description
7	number of operator tandems		=VLOOKUP($D$44,tdm_tbl,3,FALSE)	
8	total operator traffic, CCS		=D5*inputs!F91+'tandem and STP investment'!D6*inputs!F80	
9	total operator DS-3s		=H8/trk_occ/28	
10				
11	total operator positions		=H8/(inputs!C114*inputs!C115)	
12				
13	total OS tdm common equipment		=H7*inputs!C86	
14				
15	total OS tdm, per line		=H13/(D5+D6+D7)	
16				
17	total operator position investment		=H11*inputs!C113	
18				
19	total operator pos. investment/line		=H17/(D6+D5+D7)	
20				
21				
22	total OS tdm wire center		=H7*(inputs!$E$141*inputs!$D$141+inputs!$C$141)	
23				
24	total OS tdm wire center, per line		=H22/(D5+D6+D7)	
25				
26				
27				
28				
29	total additional bridge ADMs required		=4*'distance inputs'!Y2+2*'distance inputs'!AA2	The calculations in H29 - H35 compute investment in ADMs and DCSs for tandems and OS tandems as well as for inter-ring connections to produce an overall common ADM/DCS investment (H30) per line added to all lines in study area

Row	F	G	H	Description
30	total added ADM and DCS investment per line		=IF(H29<=0,0,(H29*inputs!C157+H31+H32+H34+H35)/('tandem and STP investment'!D5+'tandem and STP investment'!D6+'tandem and STP investment'!D7+D9))	
31	total tandem ADM inv per tdm loc		=IF($D$4=0,0,inputs!$C$157*'distance inputs'!AB2)	
32	total tandem DCS inv per tdm loc		=IF($D$4=0,0,$D$4*inputs!$C$164*CEILING($D$10/$D$4,1))	
33	average interoffice distance, mi		=SUMPRODUCT(output!C2:C5000,'wire center investment'!BO2:BO5000)/SUM(output!C2:C5000)	
34	total OS tdm ADM inv per loc		=IF(OS_tdm_count=0,0,OS_tdm_count*inputs!$C$157*CEILING($H$9/48/OS_tdm_count,1))	
35	total OS tdm DCS inv per loc		=IF(OS_tdm_count=0,0,OS_tdm_count*inputs!$C$164*CEILING($H$9/OS_tdm_count,1))	.
36				
37	entrance facility calculations			The calculations in this section develop investment in entrance facilities, including terminal equipment, cable, and structure; they apply only to BOCs and large ICOs (operating company types 8 and 1)
38				
39		terminal multiplexer, per line	=IF(H50=0,0,H50*CEILING((H47+H48)/672/inputs!C165/H50/48,1)*inputs!C157/(D5+D6+D7+D9))	
40		cable investment, per line	=inputs!C38*H49*inputs!C192/(D5+D6+D7+D9)	
41		u/g placement, per line	=$H$50*inputs!$C$38*inputs!$E$196/($D$5+$D$6+$D$7+$D$9)	
42		buried placement, per line	=$H$50*inputs!$C$38*inputs!$E$195/($D$5+$D$6+$D$7+$D$9)	
43		pole inv, per line	=$H$50*inputs!$C$38*inputs!$E$194/($D$5+$D$6+$D$7+$D$9)	
44		pullbox inv, per line	=$H$50*inputs!$C$38*inputs!$E$197/($D$5+$D$6+$D$7+$D$9)	
45		conduit inv, per line	=$H$50*inputs!$C$38*inputs!$E$198/($D$5+$D$6+$D$7+$D$9)	
46		total per line e.f. investment	=IF(tdm_count>0,SUM(H39:H45),0)	
47		total SA lines	=D9	

Row	F	G	H	Description
48		total switched access trunks	=SUM('wire center investment'!$BS$2:$BS$5000)-'tandem and STP investment'!H47	
49		total OC-48s, w/fill	=CEILING((H47+H48)/inputs!C165/672/48,1)	
50		no. of entrance facilities	=D4*inputs!C40	

Column	Name	Formula	Description
A	location	='loop db inputs'!A2	repeats wire center location ID
B	switches required	=IF(F2=0,0,MAX(0,CEILING((BM2*IF(('loop db inputs'!E2+'loop db inputs'!G2)/F2<inputs!$C$22,inputs!$C$20/inputs!$C$19,inputs!$C$20+(inputs!$C$21-inputs!$C$20)*((('loop db inputs'!E2+'loop db inputs'!G2)/F2)-inputs!$C$22)/(1-inputs!$C$22))/inputs!$C$19)/VLOOKUP(F2,sw_capacity,2),1),CEILING(BN2/VLOOKUP(F2,sw_capacity,3),1)))	computes number of switches required in wire center by considering switch port, real time, and traffic limits
C	total lines	='loop db inputs'!D2	Repeats total lines, including switched and special access, served by wire center
D	total residential lines	='loop db inputs'!F2	repeats total residential lines from loop db input sheet
E	total business + public lines	='loop db inputs'!E2+'loop db inputs'!G2	calculates sum of business and public lines in wire center
F	total switched lines	='loop db inputs'!E2+'loop db inputs'!F2+'loop db inputs'!G2	calculates total switched lines (residential + business + public) in wire center
G	host/remote indicator (user defined)	=IF(AND(COUNTA('host remote'!A:A)>1,hr_enable),IF(ISNA(VLOOKUP(A2,host_list,1,FALSE)),IF(ISNA(VLOOKUP(A2,remote_tbl,1,FALSE)),"A","R"),"H"),"")	Indicates switch type according to user-invoked options: H = host R = remote A = autonomous blank = aggregated investment selected
H	installed EO switching per line	=IF(AND(sw_type="H",B2>1),(1-1/B2)*BU2+BV2/B2,BU2+BV2+BW2+BX2)	calculates end office switching investment per line according to switch type
I	MDF/protector investment per line	=IF('loop db inputs'!D2=0,0,inputs!$C$23*('loop db inputs'!D2-'loop db inputs'!I2)/'loop db inputs'!D2)	calculates total main distribution frame and protector investment per line, with adjustment for DLC-served lines (which do not require MDF/protector investment in wire center)
J	end office wire center per line	=IF(F2=0,0,IF(OR(sw_type="",sw_type="A"),1/F2*(VLOOKUP('wire center investment'!F2,wc_inv,7)+IF(B2>1,B2*VLOOKUP(F2/B2,wc_inv,6),0)),IF(sw_type="R",BZ2,IF(AND(sw_type="H",B2>1),BZ2+B2/F2*VLOOKUP(F2/B2,wc_inv,6),BZ2))))	calculates per-line investment in wire center facilities
K	total local direct-routed traffic, CCS	=(bus_public_lines*bus_loc_dir+res_lines*res_loc_dir)*0.5	computes total offered load for wire center for local direct-routed traffic
L	total local direct trunks required (equiv per line)	=IF($C2=0,0,1/$C2*IF(G2="H",VLOOKUP(A2,hr_tbl,30,FALSE),IF(K2<=trfc_thresh,VLOOKUP(K2,trk_table,2),CEILING(K2/inputs!$C$36,1))))	computes total local direct trunks required according to total offered load calculation and user-set inputs for maximum trunk occupancy

Column	Name	Formula	Description
M	local direct trunk investment per line	=IF($C2=0,0,$C2*L2/$AR2*$AU2)	calculates share of total interoffice facility investment assigned to local direct trunks
N	total local tandem-routed traffic, CCS	=bus_public_lines*bus_loc_tdm+res_lines*res_loc_tdm	computes total offered load for wire center for local tandem-routed traffic
O	total local tdm trks required (equiv per line)	=IF($C2=0,0,1/$C2*IF(G2="H",VLOOKUP(A2,hr_tbl,32,FALSE),IF(N2<=trfc_thresh,VLOOKUP(N2,trk_table,2),CEILING(N2/inputs!$C$36,1))))	computes total local tandem trunks required according to total offered load calculation and user-set inputs for maximum trunk occupancy
P	local tdm trk invest per line	=IF($C2=0,0,C2*O2/$AR2*$AU2)	calculates share of total interoffice facility investment assigned to local tandem trunks
Q	total OS traffic, CCS	=bus_public_lines*bus_OS+res_lines*res_OS	computes total offered load for wire center for operator services traffic
R	OS trks required (equiv per line)	=IF(C2=0,0,1/C2*IF(G2="H",VLOOKUP(A2,hr_tbl,38,FALSE),IF(Q2<=trfc_thresh,VLOOKUP(Q2,trk_table,2),CEILING(Q2/inputs!$C$36,1))))	computes total operator services trunks required according to total offered load calculation and user-set inputs for maximum trunk occupancy
S	OS trk invest per line	=IF($C2=0,0,C2*R2/$AR2*$AU2)	calculates share of total interoffice facility investment assigned to operator services trunks
T	tdm invest per line	=IF(C2=0,0,IF(tdm_count>0,('tandem and STP investment'!$D$13+inputs!$C$37*('wire center investment'!O2+AL2+AF2))*inputs!$C$25*(1+intertdm_frac),inputs!$C$80))	computes per-line investment in tandem switching equipment, including common equipment and trunk ports; selects surrogate value if company has no tandems in study area
U	tandem wire center inv per line	=IF(tdm_count>0,'tandem and STP investment'!$D$15,inputs!$D$80)	computes per-line investment in tandem wire center facility; selects surrogate value if company has no tandems in study area Assumes tandem shares wire center with at least one end office switch
V	OS tdm invest per line	=IF(C2=0,0,IF(OS_tdm_count>0,('tandem and STP investment'!$H$15+inputs!$C$37*'wire center investment'!R2),inputs!$C$81))	computes per-line investment in operator tandem switching equipment, including common equipment and trunk ports; selects surrogate value if company has no OS tandems in study area
W	OS tandem wire center inv per line	=IF(OS_tdm_count>0,'tandem and STP investment'!$H$24,inputs!$D$81)	computes per-line investment in operator tandem wire center facility; selects surrogate value if company has no OS tandems in study area
X	operator position inv per line	='tandem and STP investment'!$H$19	repeats investment per line in operator position equipment

Column	Name	Formula	Description
Y	STP inv per line	=IF(F2=0,0,IF(STP_count>0,('tandem and STP investment'!$D$23+Z2*(inputs!$C$97/2)),inputs!$C$79))	computes STP investment per line; if company has no STPs in study area, calculation produces surrogate value
Z	# links required (equiv per line)	=IF(C2=0,0,1/C2*IF(G2="H",VLOOKUP(A2,hr_tbl,43,FALSE),2*CEILING((bus_public_lines*bus_BHCA+res_lines*res_BHCA)*inputs!$F$63,1))+IF(OR('loop db inputs'!B2=8,COUNT('loop db inputs'!$B$2:$B$5000)>50),'tandem and STP investment'!$D$56,0))	total signaling links required by switches in wire center, expressed per line
AA	link investment per line	=IF($C2=0,0,C2*Z2/$AR2*$AU2+IF(STP_count>0,0,inputs!$D$82))	assigns signaling link share of total interoffice facility investment per line; adds surrogate value for tandem A links if company has no STPs in study area
AB	total direct routed access traffic, CCS	=bus_public_lines*bus_acc_dir+res_lines*res_acc_dir	computes total offered load for wire center for direct routed access traffic
AC	total direct routed access trunks (equiv per line)	=IF(C2=0,0,1/C2*IF(G2="H",VLOOKUP(A2,hr_tbl,40,FALSE),IF(AB2<=trfc_thresh,VLOOKUP(AB2,trk_table,2),CEILING(AB2/inputs!$C$36,1)))+AF2)	computes total direct-routed access trunks required according to total offered load calculation and user-set inputs for maximum trunk occupancy
AD	dedicated access trk inv per line	=IF($C2=0,0,C2*AC2/$AR2*$AU2)	calculates share of total interoffice facility investment assigned to direct-routed access trunks
AE	total tandem-routed access traffic, CCS	=bus_public_lines*bus_acc_tdm+res_lines*res_acc_tdm	computes total offered load for wire center for tandem routed access traffic
AF	total tandem-routed access trunks (equiv per line)	=IF(C2=0,0,1/C2*IF(G2="H",VLOOKUP(A2,hr_tbl,42,FALSE),IF(AE2<=trfc_thresh,VLOOKUP(AE2,trk_table,2),CEILING(AE2/inputs!$C$36,1))))	computes total tandem-routed access trunks required according to total offered load calculation and user-set inputs for maximum trunk occupancy
AG	switched access trk inv per line	=IF($C2=0,0,C2*AF2/$AR2*$AU2)	calculates share of total interoffice facility investment assigned to switched access trunks
AH	total intraLATA direct-routed traffic, CCS	=(bus_public_lines*bus_LATA_dir+res_lines*res_LATA_dir)*0.5	computes total offered load for wire center for direct-routed intraLATA toll traffic
AI	total intraLATA direct trunks (equiv per line)	=IF(C2=0,0,1/C2*IF(G2="H",VLOOKUP(A2,hr_tbl,34,FALSE),IF(AH2<=trfc_thresh,VLOOKUP(AH2,trk_table,2),CEILING(AH2/inputs!$C$36,1))))	computes total direct-routed intraLATA toll trunks required according to total offered load calculation and user-set inputs for maximum trunk occupancy
AJ	intraLATA trk inv (direct) per line	=IF($C2=0,0,C2*AI2/$AR2*$AU2)	calculates share of total interoffice facility investment assigned to direct-routed intraLATA toll trunks
AK	total intraLATA tandem-routed traffic, CCS	=bus_public_lines*bus_LATA_tdm+res_lines*res_LATA_tdm	computes total offered load for wire center for tandem-routed intraLATA toll traffic

Column	Name	Formula	Description
AL	total intraLATA tandem trunks (equiv per line)	=IF(C2=0,0,1/C2*IF(G2="H",VLOOKUP(A2,hr_tbl,36,FALSE),IF(AK2<=trfc_thresh,VLOOKUP(AK2,trk_table,2),CEILING(AK2/inputs!$C$36,1))))	computes total tandem-routed intraLATA toll trunks required according to total offered load calculation and user-set inputs for maximum trunk occupancy
AM	intraLATA trk inv (tandem) per line	=IF($C2=0,0,C2*AL2/$AR2*$AU2)	calculates share of total interoffice facility investment assigned to tandem-routed intraLATA toll trunks
AN	total public telephone investment per line	=IF(F2=0,0,'loop db inputs'!G2*inputs!$C$120/F2)	calculates investment in public telephone station equipment per line
AO	normalized SA lines	=IF(C2=0,0,1/C2*IF(G2="H",VLOOKUP(A2,hr_tbl,47,FALSE),'loop db inputs'!H2))	calculates special access fraction of total lines; adds host/remote totals for host switches when host/remote calculations enabled
AP	normalized SA investment	=IF($C2=0,0,C2*AO2/$AR2*$AU2)	assigns special access fraction of interoffice investment per line
AQ	total switched trunks	=IF(C2=0,0,C2*(AF2+'wire center investment'!AI2+'wire center investment'!AC2+'wire center investment'!Z2+'wire center investment'!R2+'wire center investment'!O2+'wire center investment'!L2+AL2))	calculates total switched trunks in wire center (not normalized to line count)
AR	total DS-0 equivalents, with SA	=IF(C2=0,0,C2*(AF2+'wire center investment'!AI2+'wire center investment'!AC2+'wire center investment'!Z2+'wire center investment'!R2+'wire center investment'!O2+'wire center investment'!L2+AL2+AO2))	calculates total DS-0 circuits required, including special access lines
AS	SA fraction of DS-0s	=1-AQ2/AR2	calculates special access fraction of total DS-0s
AT	total fiber cable investment per line	=IF(C2=0,0,1/C2*(BO2*inputs!$C$192))	calculates total optical fiber cable investment per line
AU	total facility investment per line	=AT2+AV2+AW2+AX2+AY2+AZ2+IF(AND(ring_ind=0,loc_tdm_ind=0),CC2,0)	calculates total per-line investment in cable and structure, including poles, manholes, conduit, and buried and underground placement
AV	total aerial structure (poles) inv per line	=IF(C2=0,0,BO2*inputs!$E$194/C2)	calculates total investment per line in poles for interoffice facilities
AW	total u/g structure (conduit plcmt) inv per line	=IF(C2=0,0,BO2*inputs!$E$196/C2)	calculates total investment per line in conduit placement for interoffice facilities
AX	total pullbox inv per line	=IF(C2=0,0,BO2*inputs!$E$197/C2)	calculates total investment per line in pullboxes for interoffice facilities
AY	total buried plcmt inv per line	=IF(C2=0,0,BO2*inputs!$E$195/C2)	calculates total investment per line in buried placement for interoffice facilities
AZ	total conduit inv per line	=IF(C2=0,0,BO2*inputs!$E$198/C2)	calculates total investment per line in conduit for interoffice facilities

Column	Name	Formula	Description
BA	total DS-1 equivalents (w/sizing factor)	=CEILING(AR2/inputs!$C$165/24,1)	calculates total DS-1s for wire center, including facility sizing factor
BB	total DS-3 equivalents	=CEILING(BA2/28,1)	calculates total DS-3 equivalents from DS-1 total
BC	transmission terminal investment per line	=IF(sw_type="R",VLOOKUP(A2,remote_tbl,27,FALSE),IF(C2=0,0,1/C2*(IF(BP2=1,(inputs!$C$159-(12-CEILING((BA2+(K2+AI2)/24/inputs!$C$165)/7,1)*inputs!$C$149)),(IF(BB2<=12, inputs!$C$158,inputs!$C$157)+IF(CF2>max_rate,(CEILING(CF2/max_rate,1)-1)*inputs!$C$157)+CEILING(BB2/3,1)*inputs!$C$159))+'tandem and STP investment'!$H$30+inputs!$C$164*BB2)+IF(sw_type="H",VLOOKUP(A2,hr_tbl,28,FALSE),0))+1/C2*IF(BO2<inputs!$C$163,0,inputs!$C$162*(CEILING(BO2/inputs!$C$163,1)-1))+IF(AND(ring_ind=0,loc_tdm_ind=0),CB2,0))	computes total transmission terminal investment per line, including regenerators and additional ADMs required for inter-ring connections, tandem and OS tandem ring connections; includes capacity for ring transiting traffic
BD	land investment per line	=IF(F2=0,0,1/F2*VLOOKUP(F2,wc_inv,8))	calculates land investment per line for wire center
BE	total DLC lines	='loop db inputs'!I2	repeats total DLC line count for wire center
BF	total common transport inv per line	=P2+AG2+AM2	calculates total investment per line in common (tandem) transport facilities
BG	total dedicated transport per line	=AD2+AP2	calculates total investment in dedicated transport facilities
BH	common fraction	=IF($BF2+$BG2+$BK2=0,0,$BF2/($BF2+$BG2+$BK2))	calculates common transport fraction of total transport facilities investment
BI	direct fraction	=IF($BF2+$BG2+$BK2=0,0,$BK2/($BF2+$BG2+$BK2))	calculates direct transport fraction of total transport facilities investment
BJ	dedicated fraction	=IF($BF2+$BG2+$BK2=0,0,$BG2/($BF2+$BG2+$BK2))	calculates dedicated transport fraction of total transport facilities investment
BK	total direct transport inv per line	=M2+S2+AJ2	calculates total investment per line in direct transport facilities
BL	ring distance	=IF(ring_ind=1,VLOOKUP(A2,ring_list,2,FALSE)*ring_dstnc_adj,0)	obtains ring distance (or spur distance for off-ring wire centers) from distance inputs table for companies for which rings are constructed; distance increased by adjustment factor to account for inter-ring connections
BM	BHCA	=bus_public_lines*bus_BHCA+res_lines*res_BHCA	calculates total busy-hour call attempts for wire center
BN	total BH offered traffic, CCS	=('loop db inputs'!$E2+'loop db inputs'!$G2)*inputs!$D$73+'loop db inputs'!$F2*inputs!$D$72	calculates total busy-hour offered load for wire center

Column	Name	Formula	Description
BO	effective interoffice distance	=IF(ring_ind=1,BL2,IF(BT2=0,2*VLOOKUP(A2,dist_tbl,3,FALSE),2*avg_tdm_ds tnc))	calculates effective interoffice distance as ring distance (or spur distance) if rings are calculated for company, otherwise produces distance to nearest BOC wire center (doubled to allow for route diversity)
BP	small office indicator	=IF('loop db inputs'!D2<sm_off_ind,1,0)	indicates (=1) if switched line total in wire center falls below user-set small office threshold value
BQ	channel bank investment for unmultiplexed SA lines per line	=IF(C2=0,0,1/C2*inputs!$C$160*CEILING(inputs!$C$161*'loop db inputs'!H2*(1-BE2/C2)/inputs!$C$165/24,1))	computes channel bank investment required to multiplex special access lines not served by DLC
BR	spare		
BS	total access circuits	=AR2*BJ2	
BT	ML ind	=IF(ISNA(VLOOKUP(A2,dist_tbl,1,FALSE)),1,0)	missing location indicator; provided as check for wire centers in loop data not appearing in distance data; normally 0
BU	autonomous switch investment per line	=IF(C2=0,0,IF(sw_type="A",1/C2*VLOOKUP(F2/B2/line_fill,sw_inv_tbl,IF(OR(BY2=8,BY2=1),2,8))+VLOOKUP(F2/B2/line_fill,sw_inv_tbl,IF(OR(BY2=8,BY2=1),5,11))-inputs!$C$37/6-inputs!$C$24*(BE2)/'loop db inputs'!D2+(Z2*inputs!$C$97/2+C2/F2*inputs!$C$37*(L2*2+O2+R2+AC2+AF2+AI2*2+AL2)),IF(AND(sw_type="H",B2>1),1/C2*VLOOKUP(F2*(1-1/B2)/B2/line_fill,sw_inv_tbl,IF(OR(BY2=8,BY2=1),2,8))+VLOOKUP(F2*(1-1/B2)/B2/line_fill,sw_inv_tbl,IF(OR(BY2=8,BY2=1),5,11))-inputs!$C$37/6-inputs!$C$24*(BE2)/'loop db inputs'!D2+(Z2*inputs!$C$97/2+C2/F2*inputs!$C$37*(L2*2+O2+R2+AC2+AF2+AI2*2+AL2)),0)))*sw_install_mult	computes investment per line in autonomous, or "stand-alone," switches; if host switch appears in multiple-switch wire centers, autonomous calculation applied to all but the first switch in the wire center
BV	host switch investment per line	=IF(sw_type="H",VLOOKUP(A2,hr_tbl,22,FALSE),0)	obtains host switch investment per line from host/remote calculations
BW	remote switch investment per line	=IF(sw_type="R",VLOOKUP(A2,remote_tbl,21,FALSE),0)	obtains remote switch investment per line from host/remote calculations
BX	aggregate switch investment	=IF(sw_type="",IF(OR(BY2=8,BY2=1),inputs!$C$3,inputs!$C$2)+inputs!$C$4*LN(F2/B2/inputs!$C$18)-inputs!$C$37/6-inputs!$C$24*(BE2)/'loop db inputs'!D2+(Z2*inputs!$C$97/2+C2/F2*inputs!$C$37*(L2*2+O2+R2+AC2+AF2+AI2*2+AL2)),0)/line_fill*sw_install_mult	computes end office switch investment per line when host/remote calculations are not enabled using aggregated investment input values that address host, remote, and antonomous switches
BY	company type	='loop db inputs'!B2	repeats operating company type code
BZ	host/remote wire center inv per line	=IF(sw_type="H",VLOOKUP(A2,hr_tbl,20,FALSE),IF(sw_type="R",VLOOKUP(A2,remote_tbl,19,FALSE),0))	obtains per-line wire center investment from host/remote calculations

Column	Name	Formula	Description
CA	spare		determines distance over which facilities must be leased for companies without tandems in study area; the distance is the tandem distance between the BOC wire center to which the switch connects and the BOC tandem
CB	leased facility quasi-investment per line, terminal	=IF(AND(CD2=0,C2>0),term_equiv_inv*AR2/C2,0)	estimates surrogate investment for leased facility terminal equipment using monthly cost factor and representative monthly tariff input
CC	leased facility quasi-investment per line, facility	=IF(AND(CD2=0,C2>0),fac_equiv_inv*AR2/C2,0)	estimates surrogate investment for leased facility using monthly cost factor and representative monthly tariff input
CD	local tandem indicator (1 = yes)	=IF(VLOOKUP(A2,dist_tbl,6,FALSE)=VLOOKUP(A2,dist_tbl,10,FALSE),1,0)	indicates whether company has local tandem
CE	ring indicator (1 = yes)	=IF(OR(ISNA(VLOOKUP(A2,ring_list,1,FALSE)),BT2=1),0,1)	indicates whether rings have been calculated for company
CF	effective DS3s in local ring	=IF(OR(BT2=1,transit_fac=1,CE2=0),0,VLOOKUP(A2,ring_list,5,FALSE)*(1+transit_fac)/2/(1-transit_fac))	obtains total DS-3 count in ring, including contributions from small offices connected by spurs to wire centers on ring; transiting traffic adjustment made in terminal investment calculation
CG	spare		obtains tandem distance for BOC wire center to which small office connects if company has no tandems in study area

Column	Name	Formula	Description
A	wire center	='wire center investment'!A2	repeats wire center location code
B	total switched lines	='wire center investment'!F2	repeats total switched line count for wire center
C	end office switching inv per line	='wire center investment'!H2	repeats end office switching investment per line
D	MDF/protector inv per line	='wire center investment'!I2	repeats MDF/protector investment per line; applies to non-DLC lines
E	end office wire center inv per line	='wire center investment'!J2	repeats end office wire center investment per line
F	land per line	='wire center investment'!BD2	repeats wire center land investment per line
G	local tdm switching per line	='wire center investment'!T2	repeats tandem investment per line
H	local tdm wire center per line	='wire center investment'!U2	repeats wire center investment for local tandem per line
I	OS tdm switching per line	='wire center investment'!V2	repeats operator tandem investment per line
J	OS tdm wire center per line	='wire center investment'!W2	repeats wire center investment per line for OS tandem
K	OS trunk inv per line	='wire center investment'!S2	repeats investment per line in operator trunks
L	operator position inv per line	='wire center investment'!X2	repeats operator positions investment per line
M	common transport, u/g cable inv per line	=BH2*BV2	assigns cable facility investment to underground common transport
N	common transport, buried cable inv per line	=BI2*BV2	assigns cable facility investment to buried common transport
O	common transport, aerial cable inv per line	=BJ2*BV2	assigns cable facility investment to aerial common transport
P	common transport, pole inv per line	=BK2*BV2	assigns pole investment to common transport including effects of sharing interoffice and feeder structure
Q	common transport, conduit inv per line	=BL2*BV2	assigns conduit investment to common transport including effects of sharing interoffice and feeder structure
R	common transport, pullbox inv per line	=BM2*BV2	assigns pullbox investment to common transport including effects of sharing interoffice and feeder structure
S	common transmission terminal inv per line	=BV2*'wire center investment'!BC2	assigns transmission terminal investment to common transport

Column	Name	Formula	Description
T	direct transport, u/g cable inv per line	=BH2*BW2	assigns cable facility investment to underground direct transport
U	direct transport, buried cable inv per line	=BI2*BW2	assigns cable facility investment to buried direct transport
V	direct transport, aerial cable inv per line	=BJ2*BW2	assigns cable facility investment to aerial direct transport
W	direct transport, pole inv per line	=BK2*BW2	assigns pole investment to direct transport including effects of sharing interoffice and feeder structure
X	direct transport, conduit inv per line	=BL2*BW2	assigns conduit investment to direct transport including effects of sharing interoffice and feeder structure
Y	direct transport, pullbox inv per line	=BM2*BW2	assigns pullbox investment to direct transport including effects of sharing interoffice and feeder structure
Z	direct transmission terminal inv per line	=BW2*'wire center investment'!BC2	assigns transmission terminal investment to direct transport
AA	dedicated transport, u/g cable inv per line	=BH2*BX2	assigns cable facility investment to underground dedicated transport
AB	dedicated transport, buried cable inv per line	=BI2*BX2	assigns cable facility investment to buried dedicated transport
AC	dedicated transport, aerial cable inv per line	=BJ2*BX2	assigns cable facility investment to aerial dedicated transport
AD	dedicated transport, pole inv per line	=BK2*BX2	assigns pole investment to dedicated transport including effects of sharing interoffice and feeder structure
AE	dedicated transport, conduit inv per line	=BL2*BX2	assigns conduit investment to dedicated transport including effects of sharing interoffice and feeder structure
AF	dedicated transport, pullbox inv per line	=BM2*BX2	assigns pullbox investment to dedicated transport including effects of sharing interoffice and feeder structure
AG	dedicated transmission terminal inv per line	=BX2*'wire center investment'!BC2+'tandem and STP investment'!$H$46+'wire center investment'!BQ2	assigns transmission terminal investment to dedicated transport
AH	equiv per line local direct trunks	='wire center investment'!L2	repeats total local direct trunk count expressed per line

Column	Name	Formula	Description
AI	equiv per line local tandem trunks	='wire center investment'!O2	repeats total local tandem trunk count expressed per line
AJ	equiv per line intraLATA direct trunks	='wire center investment'!AI2	repeats total intraLATA direct trunk count expressed per line
AK	equiv per line intraLATA tandem trunks	='wire center investment'!AL2	repeats total intraLATA tandem trunk count expressed per line
AL	equiv per line direct-routed access trunks	='wire center investment'!AC2+'wire center investment'!AO2	repeats total direct-routed access trunk count expressed per line
AM	equiv per line tandem-routed access trunks	='wire center investment'!AF2	repeats total tandem-routed access trunk count expressed per line
AN	equiv per line operator trunks	='wire center investment'!R2	repeats total operator trunk count expressed per line
AO	SCP inv per line	=IF(OR('loop db inputs'!B2=8,STP_count>0),'tandem and STP investment'!$D$59,inputs!$C$82)	determines SCP investment per line as calculated value or surrogate value for companies without STPs in study area
AP	SCP+STP wire center inv per line	=IF(OR('loop db inputs'!B2=8,STP_count>0),('tandem and STP investment'!$D$60+'tandem and STP investment'!$D$22),inputs!$D$79)	repeats wire center investment per line for SCP and STP
AQ	STP inv per line	='wire center investment'!Y2	repeats STP investment per line
AR	signaling link inv per line	='wire center investment'!AA2	repeats signaling link investment per line
AS	total public telephone inv per line	='wire center investment'!AN2	repeats public telephone station equipment investment per line
AT	total residential annual DEMs per line	=inputs!$F$44	repeats average annual residential DEMs per line
AU	total business annual DEMs per line	=inputs!$F$43	repeats average annual business DEMs per line
AV	total fdr pullbox inv per line	=IF('loop db inputs'!D2=0,0,'loop db inputs'!O2/'loop db inputs'!D2-BO2*('loop db inputs'!O2/'loop db inputs'!D2)/('loop db inputs'!O2/'loop db inputs'!D2+BG2))	computes feeder pullbox investment per line with effects of sharing with interoffice structure
AW	copper fdr u/g placement per line	=IF('loop db inputs'!D2='loop db inputs'!I2,0,IF('loop db inputs'!N2=0,0,'loop db inputs'!N2/('loop db inputs'!D2-'loop db inputs'!I2)-$BQ2*('loop db inputs'!N2/('loop db inputs'!D2-'loop db inputs'!I2))/('loop db inputs'!N2/('loop db inputs'!D2-'loop db inputs'!I2)+BD2)))	computes copper feeder underground placement per line with effects of sharing with interoffice structure
AX	fiber fdr u/g placement per line	=IF('loop db inputs'!I2=0,0,IF('loop db inputs'!M2=0,0,'loop db inputs'!M2/'loop db inputs'!I2-$BQ2*('loop db inputs'!M2/'loop db inputs'!I2)/('loop db inputs'!M2/'loop db inputs'!I2+BD2)))	computes fiber feeder underground placement per line with effects of sharing with interoffice structure

Equation Listing

Column	Name	Formula	Description
AY	copper feeder buried plcmt per line	=IF('loop db inputs'!D2='loop db inputs'!I2,0,IF('loop db inputs'!L2=0,0,'loop db inputs'!L2/('loop db inputs'!D2-'loop db inputs'!I2)-$BS2*('loop db inputs'!L2/('loop db inputs'!D2-'loop db inputs'!I2))/('loop db inputs'!L2/('loop db inputs'!D2-'loop db inputs'!I2)+BE2)))	computes copper feeder buried placement investment per line with effects of sharing with interoffice structure
AZ	fiber feeder buried plcmt per line	=IF('loop db inputs'!I2=0,0,IF('loop db inputs'!K2=0,0,'loop db inputs'!K2/'loop db inputs'!I2-$BS2*('loop db inputs'!K2/'loop db inputs'!I2)/('loop db inputs'!K2/'loop db inputs'!I2+BE2)))	computes fiber feeder buried placement investment per line with effects of sharing with interoffice structure
BA	total fdr pole inv per line	=IF('loop db inputs'!D2=0,0,('loop db inputs'!J2/'loop db inputs'!D2-BU2*('loop db inputs'!J2/'loop db inputs'!D2)/('loop db inputs'!J2/'loop db inputs'!D2+BF2)))	computes feeder pole investment per line with effects of sharing with interoffice structure
BB			
BC			
BD	total transport, u/g plcmt unadj inv per line	='wire center investment'!AW2	repeats underground placement investment for transport facilities for use in feeder sharing calculation
BE	total transport, buried plcmt unadj inv per line	='wire center investment'!AY2	repeats buried placement investment for transport facilities for use in feeder sharing calculation
BF	total transport, pole unadj inv per line	='wire center investment'!AV2	repeats pole placement investment for transport facilities for use in feeder sharing calculation
BG	total transport, pullbox unadj inv per line	='wire center investment'!AX2	repeats pullbox placement investment for transport facilities for use in feeder sharing calculation
BH	total transport, u/g cable inv per line	=IF('loop db inputs'!D2=0,0,'wire center investment'!AT2*inputs!$C$172+output!BD2-output!BQ2*BD2/(BD2+('loop db inputs'!M2+'loop db inputs'!N2)/'loop db inputs'!D2))	computes final total transport underground investment per line including effects of structure sharing with feeder
BI	total transport, buried cable inv per line	=IF('loop db inputs'!D2=0,0,('wire center investment'!AT2+'wire center investment'!BO2*inputs!$C$171)*inputs!$C$169+BE2-BS2*BE2/(BE2+('loop db inputs'!K2+'loop db inputs'!L2)/'loop db inputs'!D2))	computes final total transport buried investment per line including effects of structure sharing with feeder
BJ	total transport, aerial cable inv per line	='wire center investment'!AT2*inputs!$C$178	calculates total aerial cable investment per line for transport
BK	total transport, pole inv per line	=IF('loop db inputs'!D2=0,0,BF2-BU2*BF2/(BF2+'loop db inputs'!J2/'loop db inputs'!D2))	computes final total transport pole investment per line including effects of structure sharing with feeder
BL	total transport, conduit inv per line	='wire center investment'!AZ2	computes final transport conduit investment per line
BM	total transport, pullbox inv per line	=IF('loop db inputs'!D2=0,0,BG2-BO2*BG2/(BG2+'loop db inputs'!O2/'loop db inputs'!D2))	computes final total transport pullbox investment per line including effects of structure sharing with feeder

Column	Name	Formula	Description
BN	min pullbox inv per line (i/o, fdr)	=IF('loop db inputs'!$D2=0,0,MIN('loop db inputs'!$O2/'loop db inputs'!$D2,BG2))	determines minimum pullbox investment per line between interoffice and feeder facilities for use in structure sharing calculation
BO	basic pullbox inv reduction per line	=BN2*inputs!$C$184	computes pullbox investment reduction per line resulting from sharing of structure between interoffice and feeder facilities; applied to both interoffice and feeder totals
BP	min u/g plcmt inv per line (i/o, fdr)	=IF('loop db inputs'!$D2=0,0,MIN(BD2,('loop db inputs'!$M2+'loop db inputs'!$N2)/'loop db inputs'!$D2))	determines minimum underground placement investment per line between interoffice and feeder facilities for use in structure sharing calculation
BQ	basic u/g plcmt reduction per line	=BP2*inputs!$C$184	computes underground placement investment reduction per line resulting from sharing of structure between interoffice and feeder facilities; applied to both interoffice and feeder totals
BR	min buried plcmt inv per line (i/o, fdr)	=IF('loop db inputs'!$D2=0,0,MIN(BE2,('loop db inputs'!$K2+'loop db inputs'!$L2)/'loop db inputs'!$D2))	determines minimum buried placement investment per line between interoffice and feeder facilities for use in structure sharing calculation
BS	basic buried plcmt reduction per line	=BR2*inputs!$C$184	computes buried placement investment reduction per line resulting from sharing of structure between interoffice and feeder facilities; applied to both interoffice and feeder totals
BT	min pole inv per line (i/o, fdr)	=IF('loop db inputs'!$D2=0,0,MIN(BF2,'loop db inputs'!$J2/'loop db inputs'!$D2))	determines minimum pole investment per line between interoffice and feeder facilities for use in structure sharing calculation
BU	basic pole reduction per line	=BT2*inputs!$C$184	computes pole investment reduction per line resulting from sharing of structure between interoffice and feeder facilities; applied to both interoffice and feeder totals
BV	common fraction	='wire center investment'!BH2	repeats common investment fraction of total for use in assigning various investment to common transport
BW	direct fraction	='wire center investment'!BI2	repeats direct investment fraction of total for use in assigning various investment to direct transport
BX	dedicated fraction	='wire center investment'!BJ2	repeats dedicated investment fraction of total for use in assigning various investment to dedicated transport

Column	Name	Formula	Description
BY	ML indicator	='wire center investment'!BT2	repeats missing location indicator; normally zero

HAI Model

Release 5.0a

Automation Description and User Guide

HAI Consulting, Inc.

737 29th Street, Suite 200
Boulder, Colorado 80303

January 28, 1998

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1. General Description

The HAI Model Release 5.0a ("HM 5.0a") is developed and sponsored by HAI Consulting, Inc., AT&T Corp., and MCI Telecommunications Corporation. The Model calculates the cost of unbundled network elements (UNEs), Universal Service Funding (USF) requirements, and the cost of carrier access and interconnection through the use of a highly sophisticated costing tool.[1] The computer program chosen to support such a complicated analysis is Microsoft Excel 97. The Model's calculations are contained in four Excel workbooks; these workbooks constitute the following modules:

1. *Distribution Module*
2. *Feeder Module*
3. *Switching and Interoffice Module*
4. *Expense Module (Summarized by Density Zone, Wirecenter, CBG, or Cluster).*

A USF summary module is also provided. This module allows the user to combine and summarize the USF results from a selection of companies with previously prepared expense modules.

The HAI Model developers and sponsors believe that a model developed in a readily understandable and ubiquitous spreadsheet program will permit detailed analysis of the calculations, algorithms, and user definable inputs. Moreover, the use of Microsoft Excel's auditing tools will allow the user to determine relationships among the Model's various inputs and outputs.

While HM 5.0a remains a spreadsheet-based model, it uses two Microsoft programming languages – Visual Basic (VB) and Visual Basic for Applications (VBA) – and a database to integrate the Model's four calculating modules (See Model flowchart on the following page). The use of programming code and macros allows the model to run with limited user intervention. The programming code automates the copy and paste functions when applying intermediate results and data calculations among the Model's modules. Although the model will execute successfully on less capable machines, the recommended PC for repetitive uses of the model is a 200 MHz Pentium processor with 64Mb of RAM.

HM 5.0a takes advantage of Microsoft's object oriented structure to enhance the Model's speed and functionality. Structured Query Language (SQL) database queries have removed the need for complex and time consuming data aggregation functions within Excel, permitting the model to calculate quickly and produce results at various levels of aggregation.

Three of the model's VB/VBA calculations are performed within the database. First, the database aggregates Distribution Module results for outlier cluster and associates these results with the outlier's "home" main cluster. Second, the database aggregates investment results from the Cluster level to the Wire Center and Density Zone levels. And third, the database assigns

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[1] Please refer to the *HAI Model, Release 5.0a Model Description*, for a precise description of the Model's functions, including its evolution into the current release.

switching and interoffice investments, developed on a per-line basis, to each cluster. In both cases the Model utilizes simple arithmetic calculations that can be externally verified by the user. Use of the database increases the efficiency of the Model, but does not compromise the ability to audit the Model. A final use of VBA is in the Switching and Interoffice Module for the determination of efficiently constructed interoffice transport rings.

To improve the user's ability to audit the Model, an Excel "workfile" is generated with each run to keep track of the intermediate results of each module. Using this workfile, the user can trace the development of investment results through each of the calculating modules.

2. HAI Model 5.0a Module Flowchart

Module Flowchart
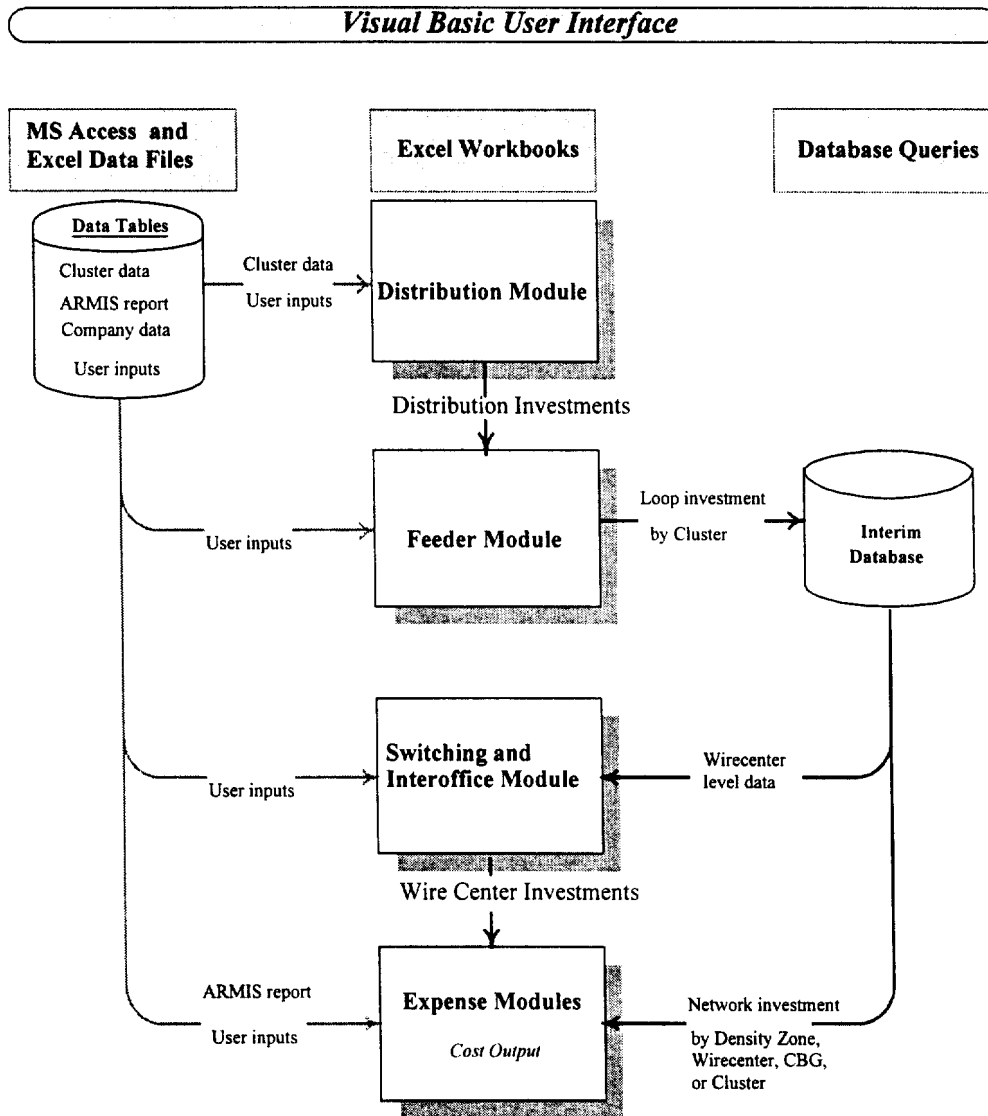
3. System Requirements

In order to run HM 5.0a your PC should meet the following requirements:

- 133 MHz or faster Pentium processor (200 MHz preferred)*
- 64 megabytes of RAM*
- SVGA monitor set to 800 x 600 (or higher) display resolution
- 400 megabytes of available hard drive capacity
- Microsoft Windows NT or Windows 95 operating system
- Microsoft Office Professional 97, with Microsoft Service Release 1 (SR-1) installed

The items marked with an asterisk (*) are recommendations, and should be followed if the Model is to be used for large companies in large states (e.g., California, New York, or Texas). For smaller companies, the Model will function on a smaller PC.

Please note that the preferred application software is Microsoft Office 97 Professional for Windows 95 that incorporates Excel 97, Access 97, and Word for Windows 97.[2] Use of this complete suite of Microsoft products will ensure that all file libraries that are needed to run the model will be installed. In addition, Word for Windows 97 permits users to examine the Model's documentation in electronic form, and Access 97 will permit the user to examine the Model's database more readily.

Users wishing to run the Model having only a stand-alone installation of Excel 97 should examine the "Readme.txt" file. This file is located in the Model's home directory or Section 8 of this documentation. The file explains instructions on how to ensure that the computer installation of supporting file libraries for Excel 97 is sufficient to run the model.

4. Installation Instructions

HM 5.0a ships on the CD-ROM as a single self-extracting installation file. To install the Model on your personal computer follow these directions.

1. Ensure that your personal computer and its software meet the system requirements described in Section 3.

2. Place the HM 5.0a CD-ROM in your PC's CD-ROM drive.

3. Locate and double click on the *File Manager* or *Windows Explorer* icon.

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[2] The HM 5.0a (for Office 97) requires the Microsoft Office 97 Service Release 1 (SR-1) update for proper operation. A copy of this service release and a program to check if it has already been installed on your PC is included with the HM 5.0a CD-ROM. Please view the "Overview_Readme.doc" file in the CD-ROM's root directory for directions on how to install the SR-1 update for Microsoft Office 97. Previous versions of the HM (Releases 3.0, 3.1 and 4.0) were developed operate under Microsoft Excel 7.0, Access 7.0, and Word for Windows 7.0. The HM 5.0a will not operate under Microsoft Excel 7.0.

4. Double click on the icon for your computer's CD-ROM drive.

5. Double click on the HM 5.0a-installation icon. The model will first check to see if a previous installation of Release 5.0a of the Hatfield/HAI Model exists on your computer. If a previous installation is found, you will be asked whether you wish this previous installation to be deleted, or the current installation process aborted. If you wish to retain your old installation of Release 5.0a, you should choose to abort the installation process and use Windows File Manager or Explorer to change the name of the old installation's *HM50a.exe* file to another name. You may then rerun the current installation process.[3]

6. The model will run a self-extraction routine that will install the Model and all of its components on your computer's internal hard drive.

7. You are now ready to run the HM 5.0a.

5. Running the Model

Select State

Running HM 5.0a is straightforward. To start the program, click on its icon under the *Programs* entry on the *Start* menu (in Windows 95 or Windows NT 4.0), or the HAI Model program group (in Windows NT 3.51). A copyright message will appear, followed by the State Selection form. From this list, select the state you desire to run, or select the Multi-Company option. The Multi-Company option is explained in the sub-section, *Multi-Company Selection*:

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[3] Note that if you decide to preserve your previous installation of the HM 5.0a or previous versions of the HM, only the most recent installation will be "active" and be executed when you click on the Model's icon or entry in the Start menu.